CEMENT AND LIME MANUFACTURE

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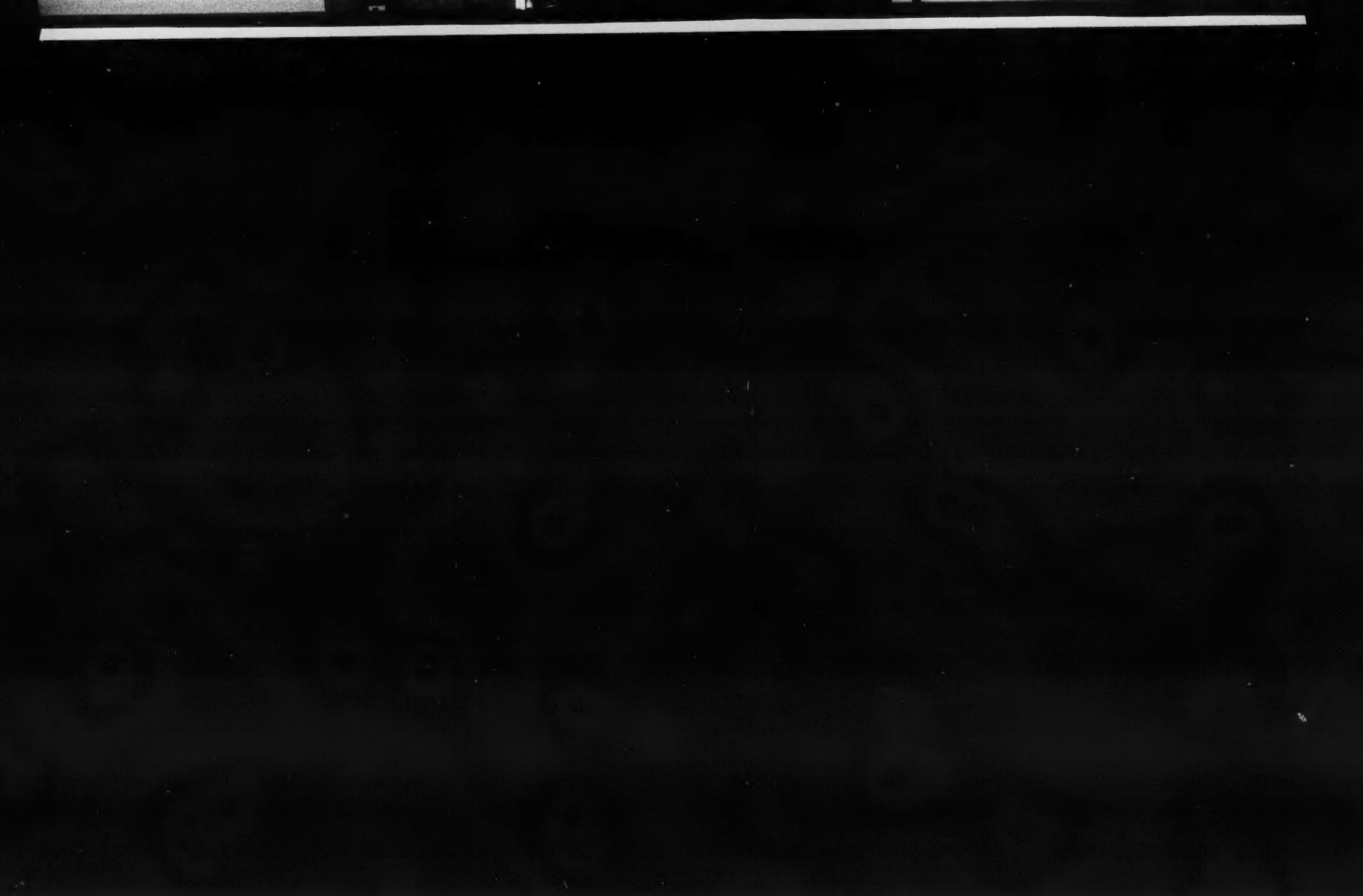

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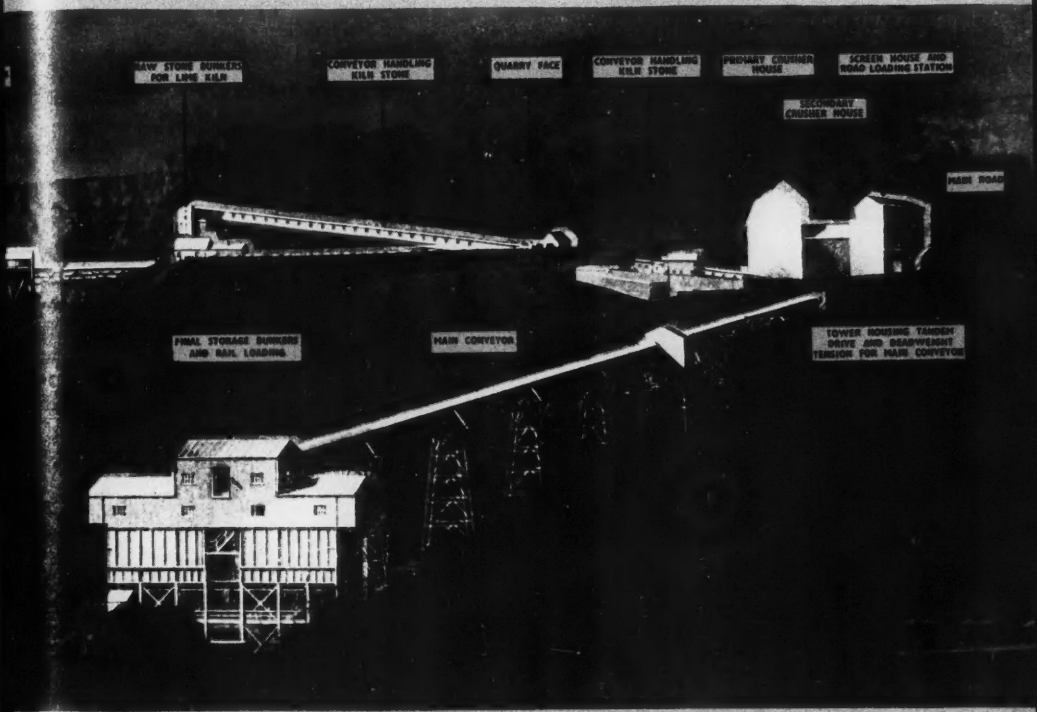
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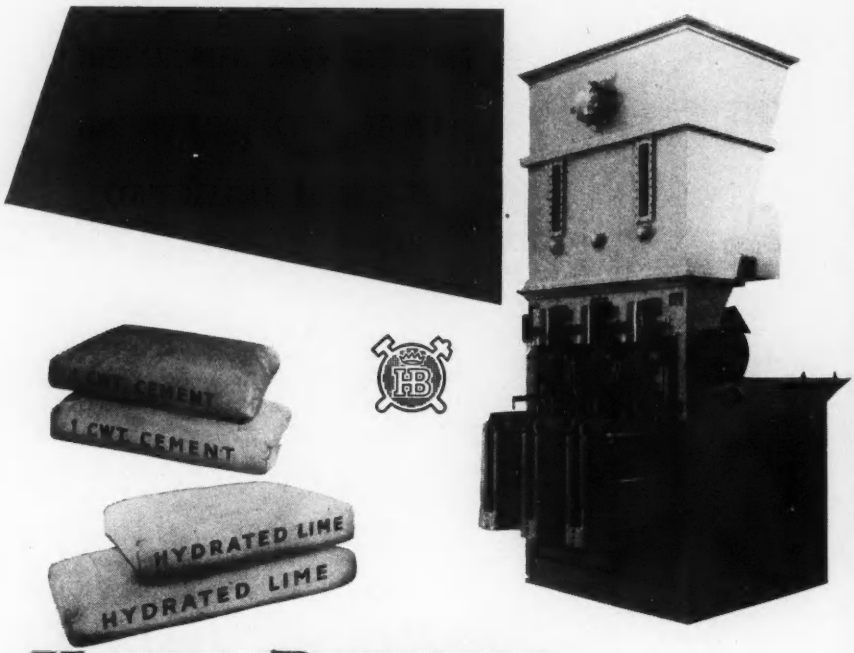

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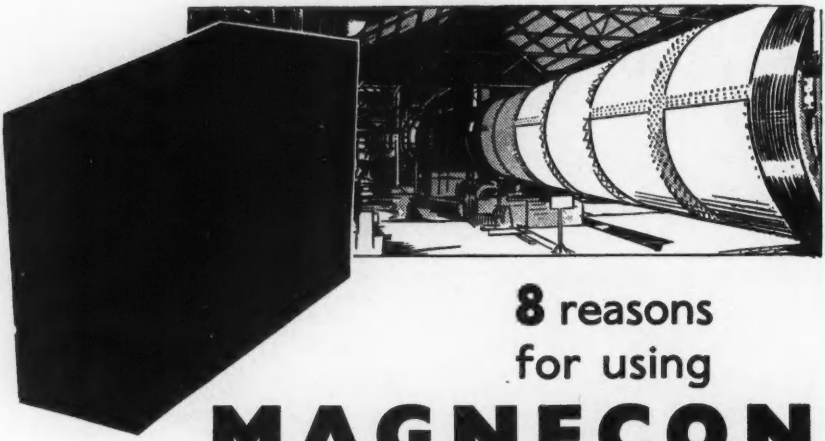

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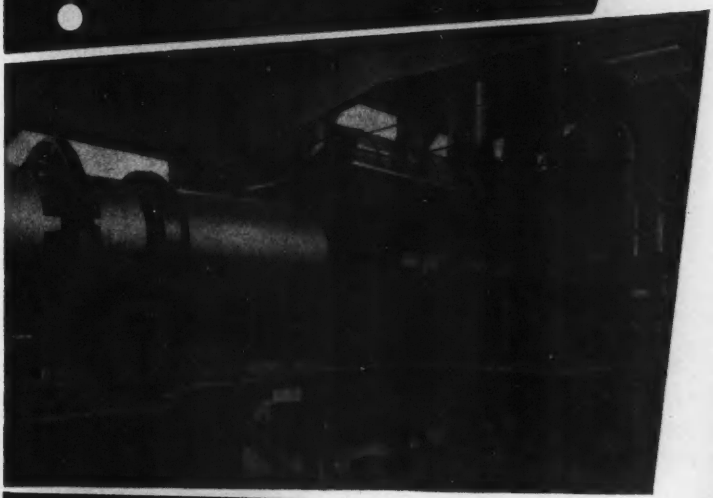

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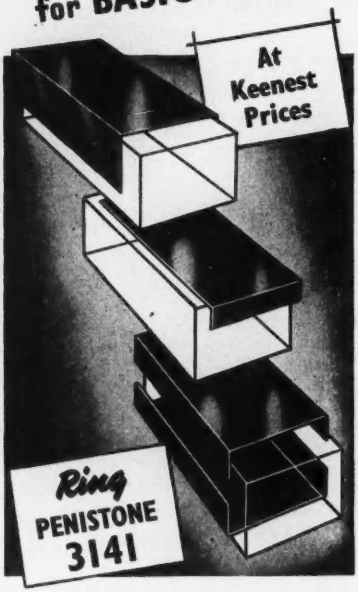

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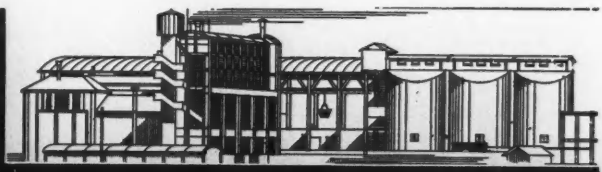

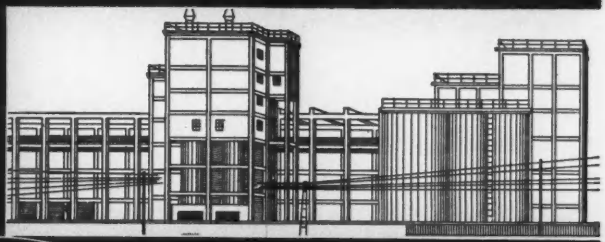

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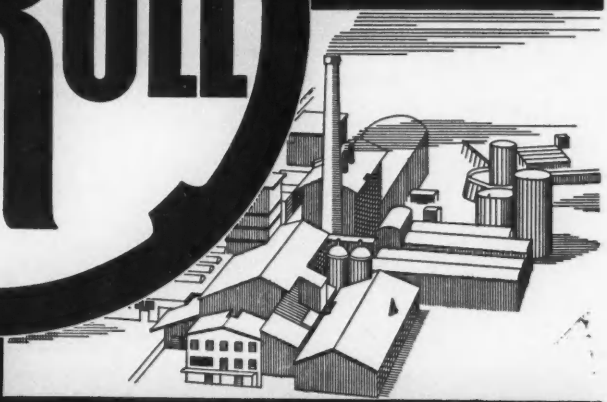

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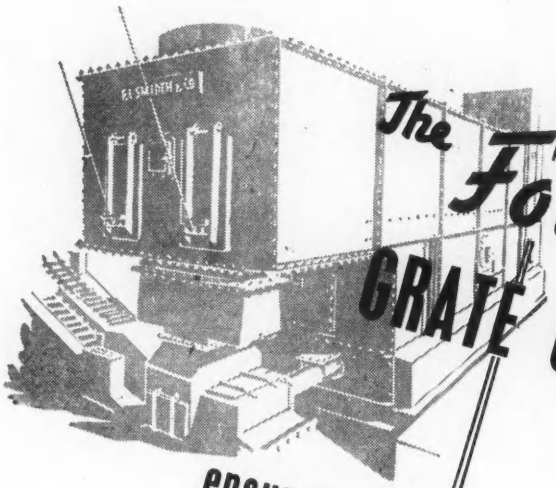

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VOLUME XXXI. NUMBER 4. JULY, 1958

A High-energy Expanding Cement.

THE development of an expanding cement with a high energy of expansion is described in a paper by Professor V. V. Mikhailov (U.S.S.R.) contributed to the World Conference on Prestressed Concrete held last year at San Francisco, U.S.A. It is made by grinding together Portland cement clinker, alumino-ferrous cement clinker, and gypsum; concrete made with this cement is stated to be waterproof and of high strength. The following is a summary of the paper.

It is known that when concrete is attacked by sulphates the interaction of calcium sulphate and aluminate hydrate (hydrocalumite) forms the mineral ettringite ($3C_aO.\ Al_2O_3.\ 3C_aSO_4.32H_2O$) which expands and disrupts hardened concrete. The possibility of utilising this reaction in such a way as to overcome the shrinkage of concrete made with ordinary Portland cement, and to produce a high resistance to sulphate attack, has been the subject of research in many countries. In Russia an expansive cement called W.R.C. was developed and first used in 1943; this is a quick-setting and rapid-hardening hydraulic cement, impermeable to water, formed by the dry grinding of alumino-ferrous cement clinker, gypsum, and hydrocalumite; the hydrocalumite is prepared by hydrating, drying, and grinding together alumino-ferrous cement and lime. *Fig.* 1 shows the successive chemical processes and the end products of hydration of W.R.C. The cement has an expansion of 1 per cent., and strengths of about 1000 lb. per square inch in six hours and 7000 lb. per square inch at 28 days. It differs basically from the expanding cement developed in France by M. Lossier (*Fig.* 2).

The expansive properties of W.R.C. cement are due to the formation of ettringite while the colloidal phase is predominant, as a result of the reaction between hydrocalumite and gypsum in surroundings saturated with hydrargillite. The stages are:

(1) $4CaO.Al_2O_3.13H_2O + 3CaSO_4.2H_2O + ag = 3CaO.Al_2O_3.2CaSO_4.32H_2O + Ca(OH)_2 + ag.$

(2) $3(4CaO.Al_2O_3.13H_2O) + Al_2O_3.3H_2O + 12CaSO_4 + ag = 4(3CaO.Al_2O_3.3Ca_3SO_4.32H_2O) + ag$.

If sulphate-bearing water should appear in the system after the hydrocalumite and gypsum are spent, the formation of ettringite continues by crystallisation, the reaction being

(3) $3(2CaO.Al_2O_3.8H_2O) + 6CaSO_4.2H_2O + ag = 2(3CaO.Al_2O_3.3CaSO_4.ag) + Al_2O_3ag$.

These reactions occur only in a system with a high water content and a continuous and unlimited flow of water.

No harmful results occur, as the formation of ettringite is completed in two or three days and the expansion takes place during the hardening period. In addition to its considerable expansion, the system obtains great density. If the cement is subjected to a water pressure of one atmosphere one hour after setting all percolation stops after six hours, and it becomes impervious to a pressure of six atmospheres in 24 hours.

This cement has no energy of expansion and exerts no pressure. It was noticed, however, that if lime be used instead of hydrocalumite the formation of ettringite, with an hexagonal structure of needles and chains, is impeded. Instead, hexagonal tables with a refraction of 1·489—1·504 appear in the hardened product; these are a new form of the "low sulphate" double salt $3CaO.Al_2O_3.CaSO_4.12H_2O$. The expansion of this cement begins only after two to five months of storage in

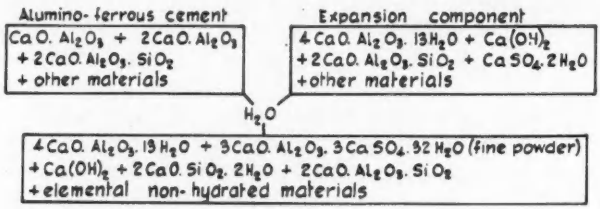

Alumino-ferrous cement
CaO. Al2O3 + 2CaO. Al2O3
+ 2CaO. Al2O3. SiO2
+ other materials
Expansion component
4CaO. Al2O3. 13H2O + Ca(OH)2
+2CaO. Al2O3. SiO2 + CaSO4. 2H2O
+other materials
H2O
4CaO. Al2O3. 13H2O + 3CaO. Al2O3. 3CaSO4. 32H2O (fine powder)
+Ca(OH)2 + 2CaO. SiO2. 2H2O + 2CaO. Al2O3. SiO2
+elemental non-hydrated materials

Fig. 1.

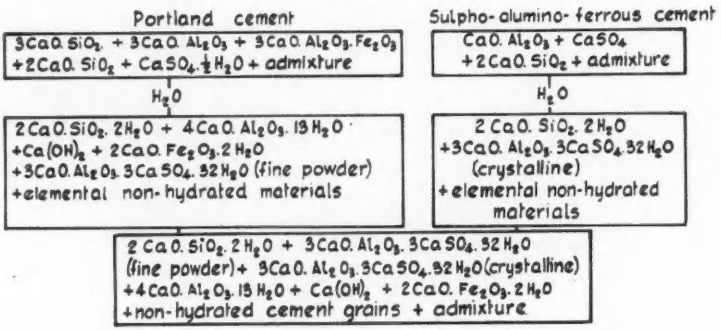

Portland cement
3CaO. SiO2 + 3CaO. Al2O3 + 3CaO. Al2O3. Fe2O3
+2CaO. SiO2 + CaSO4. ½H2O + admixture
Sulpho-alumino-ferrous cement
CaO. Al2O3 + CaSO4
+2CaO. SiO2 + admixture
H2O
H2O
2CaO. SiO2. 2H2O + 4CaO. Al2O3. 13H2O
+Ca(OH)2 + 2CaO. Fe2O3. 2H2O
+3CaO. Al2O3. 3CaSO4. 32H2O (fine powder)
+elemental non-hydrated materials
2CaO. SiO2. 2H2O
+3CaO. Al2O3. 3CaSO4. 32H2O
(crystalline)
+elemental non-hydrated materials
2CaO. SiO2. 2H2O + 3CaO. Al2O3. 3CaSO4. 32H2O
(fine powder) + 3CaO. Al2O3. 3CaSO4. 32H2O (crystalline)
+4CaO. Al2O3. 13H2O + Ca(OH)2 + 2CaO. Fe2O3. 2H2O
+non-hydrated cement grains + admixture

Fig. 2.

TABLE I

Material	Treatment	Expansion at 28 days (per cent.)	Strength (lb. per sq. in.)
Cement	6 hours' immersion at 70 deg. C.	4—6	12,800 (28 days)
Mortar	Ditto	3—5	5,700-7,100 (28 days)
Cement	1 hour's immersion at 80 deg.; water storage after	3—4	14,000 (28 days)
Mortar	Ditto	3—4	5,700-8,500 (28 days)
Cement	Boiled for 6 hours; water storage after	Not stated	14,000 (90 days)
Mortar	Ditto	2	8,500 (90 days)

water, when the " low sulphate " double salt gradually disappears and recrystallises as ettringite. At the same time the free gypsum in the system gradually disappears. This process is followed by large expansions, cracking, and rupture, and, because of its ability to disrupt the strong ties of the hardened material, this cement was used to develop a high-energy expanding cement. Portland cement is used as the basic material.

The action of this mixture of Portland cement, alumino-ferrous cement, and gypsum is as follows. As the Portland cement hardens, a framework is formed from aluminate hydrate and the " low-sulphate " double salt. A rapid precipitation of ettringite then occurs in a medium which is saturated with lime hydrate, and the disruptive effect of this precipitation can be made use of by (1) accelerating the hardening of the Portland cement so that it forms new ties in greater numbers than those destroyed by the expansion; (2) limiting the amount of gypsum; and (3) placing the material in an elastic container or restraining it with steel bars. If the expansion is so prevented or controlled large forces are exerted on the container or bars, thereby prestressing the material.

The gypsum content should not exceed 15 per cent., and the alumino-ferrous cement 20 per cent., of the total. Typical proportions are 14 per cent. of gypsum, 12 per cent. of alumino-ferrous cement, and 74 per cent. of Portland cement. It is not a true hydraulic cement. When mixed with water at normal temperatures the rate of formation of ettringite so exceeds the rate of hardening of the Portland cement that disruption occurs. At higher temperatures, however, the rate of formation of ettringite is reduced and the rate of hardening of Portland cement is accelerated. In order to obtain successful results, a combination of hydration and heat-treatment is therefore necessary.

Tests on specimens made with cement paste and 1 : 1 mortar have given the results shown in *Table* I; all the specimens were hermetically sealed by covering the surfaces with paraffin wax immediately after setting, and stored at normal temperatures for 18 hours.

The strength and expansion of concrete made with this cement depend largely on the water-cement ratio. It is extremely quick setting; it becomes plastic almost

as soon as it is mixed, and sets in about 2½ minutes. Research is now being made to determine the best method of retarding the setting. It is normally used in the proportions of about 1700 lb. per cubic yard of concrete.

The cement has been used in the manufacture of concrete pipes. In this method a cage of high-tensile steel reinforcement is placed around a cylindrical former. A machine, which is not described in the paper, then applies the mortar by means of a cement gun and removes the mould. The pipe is dipped in melted paraffin wax, stored in air at a normal temperature, and then stored for three to five days in cold water. The finished product has a compressive strength of 12,600 lb. to 14,000 lb. per square inch, a tensile strength of 560 lb. to 700 lb. per square inch, and an elastic modulus of about 5,600,000 lb. per square inch. The prestress due to the prevention of expansion by the reinforcement is about 560 lb. per square inch in the concrete and 70,000 lb. per square inch in the steel. The pipes are said to be watertight and cheaper than pipes made by other methods.

The Uttar Pradesh Cement Works, India.

Messrs. Henry Pooley wish to state, in reference to the article on the Uttar Pradesh cement works in this journal for January, March and May last, that their management of the works was for a period of three years only from August, 1954, to August, 1957.

Proposed Cement Works in Nigeria.

The Government of Northern Nigeria is considering the erection of a cement works near Jakura, in Kabba Province.

New Lime Works in Israel.

A contract has been awarded to Messrs. Edgar Allen & Co. Ltd., for the supply of machinery for a lime works to be built at Shfeya, near Haifa, for the Lime & Stone Production Co. Ltd., of Haifa. The contract includes a rotary kiln 180 ft. long by diameters of 9 ft. and 10 ft. 6 in., a preheater, a grate-cooler and ancillary equipment. The plant is designed to deal with limestone at the rate of 13 tons per hour.

The Cement Industry in China.

It is expected that 7,400,000 tons of cement will be produced in China during 1958; this is an increase of 11 per cent. over the previous year. Production of low-heat cement, oil-well cement, and high-early-strength cement will begin this year, as also will experimental production of high-strength cement, expansive silicate cement, expansive aluminate cement, and high-magnesium-oxide cement. Work will continue on new factories in Szechwan, Shansi, and Honan, two of which will be provided by Eastern Germany. New works are to be built in Kweichow, Anhwei, and Chekiang; the first two will have a capacity of 00,000 tons.

The Surface Area of Hydrated Portland Cement.

A paper by Mr. N. A. Tomes, Mr. C. M. Hunt, and Mr. R. L. Blaine on "Some Factors Affecting the Surface Area of Hydrated Portland Cement as determined by Water-Vapour and Nitrogen Adsorption," is given in the Journal of Research of the U.S. National Bureau of Standards for December 1956 (Research Paper No. 2806).

In an introduction to the paper it is stated that measurements of water vapour and nitrogen sorption, as well as other evidence, have demonstrated that the hydration products of Portland cement are largely colloidal in nature. Mr. T. C. Powers and Mr. T. L. Brownyard have carried out water-vapour adsorption measurements on a number of hydrated cements and found that v_m, the parameter in the Brunauer-Emmett-Teller (BET) equation, from which a value for specific surface is calculated, was proportional to w_n, the non-evaporable-water content of the hydrated cement. They found the ratio v_m to w_n to be relatively constant and not greatly affected by the age or water-cement ratio of the specimen. The constant proportionality between v_m and w_n indicates that surface computed from water-vapour adsorption data is proportional to the amount of hydration products present. This evidence suggests that some kind of structural similarity exists between the hydration products formed during the first few days of hydration and those formed during the later stages of hydration.

Although the constant v_m/w_n ratio for specimens made from a given cement provides an important clue in determining the submicroscopic morphology of hydrated Portland cement, both v_m and w_n are somewhat dependent upon the arbitrary conditions under which they are determined. For example, it was noted by Mr. Powers and Mr. Brownyard that successive sorption isotherms by the same specimen of hardened cement paste were not reproducible, a fact that suggests strong interaction between water vapour and one or more of the hydration products of cement. Thus, whereas specific surface is a function of the amount of hydration products present, non-reversible sorption behaviour suggests that it also depends on the history of a specimen after hydration has stopped.

The authors consider the non-reversible sorption behaviour of hydrated cement and give further examples that illustrate the effect of wetting or exposure to water vapour upon subsequent adsorption of water vapour by hardened cement paste. Nitrogen-adsorption measurements have also been made as an independent method of detecting small changes in the colloidal structure of hydrated cement.

Another factor to be considered in the determination of v_m and w_n is the difficulty of determining how much of the water in a hardened cement is chemically combined. However, by carefully controlling the conditions of drying it is possible to obtain a reproducible but arbitrary dry weight, which affords a datum from which v_m and w_n may be determined. Mr. Powers and Mr. Brownyard have determined these quantities after drying hardened cement paste in a vacuum system containing magnesium perchlorate dihydrate and tetrahydrate, whereas

Mr. L. E. Copeland and Mr. J. C. Hayes have described a procedure for vacuum-drying cement pastes which uses a dry-ice trap in the system to establish the water-vapour concentration. According to Mr. L. E. Copeland and Mr. R. H. Bragg non-evaporable water in specimens dried by the latter procedure probably corresponds rather closely to chemically-combined water. However, hardened cement pastes and hydrated calcium silicates reach constant weight almost asymptotically when dried in a vacuum at room temperature. It is common practice to discontinue drying while the specimens are still losing weight at a very small but detectable rate. Therefore the authors also consider the manner in which v_m and w_n vary when they are determined on specimens of the same paste that have been dried for different periods of time.

The authors summarise the results of the investigation as follows.

Adsorption and desorption of water vapour and repeated wetting and drying resulted in a decrease in the water-vapour sorptive capacity of hardened cement paste. Changes were also produced in the nitrogen sorptive capacity. These results do not preclude the possibility of very small losses of chemically-combined water or gains of small amounts of atmospheric contaminants; however, they probably represent shrinkage or other modification of the colloidal structure of cement paste. If surface areas calculated from sorption data are to be treated as functions of the amount of hydration products present, it is important to consider the history of a specimen after hydration has stopped.

The effect of varying the drying time before measuring the non-evaporable water content and surface area by water-vapour adsorption was also considered. When a hardened paste received successively longer drying treatments, a linear relationship between v_m and w_n was obtained as the paste approached dryness.

A New Masonry Cement.

A masonry cement is now supplied by the Cement Marketing Co., Ltd., for use in mortars for bricklaying, rendering, plastering, and non-load-bearing toppings. Tests have shown that satisfactory results are obtained with proportions of up to 6 parts by volume of well-graded sand to 1 part of this cement, and the properties of the mortar are stated to include low shrinkage and moisture movement, resistance to the effects of frost, a high degree of plasticity, workability, and cohesiveness, and a greater resistance to attack by sulphates than that of ordinary mortar. The cement is known as " Walcrete."

Large Kiln Proposed for Portugal.

It is reported that the Italian concern Companhia Cimento Tejo has ordered from the French firm of Fives-Lille what is thought to be the largest cement kiln in the world, with a capacity of 1,600 tons daily. The kiln will be 546ft. in length with a diameter of 17 ft. 6 in., and would come into operation in the middle of 1959.

The Setting of Portland Cement.

IN an article in "Zement-Kalk-Gips" for January, 1957, R. Hayden puts forward the following theory of the process of setting of Portland cement based on an investigation of the change that takes place in cement before hardening begins.

At the end of the standard setting period of ordinary Portland cement, about 0·45 to 0·75 parts of water (according to the fineness of the cement) have reacted with 100 parts of cement. About three-quarters of this water is combined as calcium hydroxide, so that 100 parts of set cement contain 1·25 to 2·5 parts of calcium hydroxide. Assuming that the remaining quarter of the water is combined in hydrated tricalcium sulphoaluminate, the 100 parts of cement form 0·5 part of this compound. If such small quantities of these substances cause setting, their physical form must be of great significance, and the binding forces are not likely to be of chemical origin.

If 100 parts of cement are gauged with 25 parts of water, only a fraction of the hydrated lime liberated on setting can dissolve, so that it is mainly deposited in the solid form. The crystals are presumably extremely minute: as they are formed they absorb water in increasing amounts and the clinker particles are bound together by a pseudo-solid aqueous film. The tricalcium sulphoaluminate hydrate also gradually appears in the form of very fine crystals.

It follows from this assumption that a set cement paste would disintegrate spontaneously into cement on being shaken with alcohol. This expectation was confirmed. After extracting the paste with alcohol and drying at 105 deg. C., the recovered cement hardened normally when again gauged with water. This process of setting with water, extracting with alcohol, and drying, can be repeated many times without loss of activity of the cement; the limit to this was not investigated. If the lime formed during setting contributed to the setting process, then its effect might be expected to be cumulative on repeated extraction with alcohol, but this is not observed.

In a trial with a Ferrari cement, slow setting was observed even without the addition of gypsum, although the same amount of calcium hydroxide was formed on setting as in the case of Portland cement. In general the degree of dispersion of calcium hydroxide is influenced by gypsum.

It is concluded that calcium hydroxide, in whatever form or amount it is present, is not directly associated with the setting process, but that the setting of a Portland cement of any kind, when gauged with water, is the external manifestation of an increasing adsorption of water due to the formation of increasing areas of surfaces capable of adsorbing. The effect of surface area can be demonstrated by adding 0·1 per cent of graphite with a specific surface of 35,000 sq. cm. per gramme, which causes a marked reduction of the setting time.

The set determined by the Vicat method is an arbitrary stage of the setting process, not the hardening process. For example, a pat which, when tested by the Vicat method, is "set" after five hours can still be "dissolved" in alcohol after six or seven hours; in this case at about ten hours the alcohol would be

ineffective. A cement made from clinker without gypsum, and setting 45 minutes after gauging, bound no more water during setting than a normal cement from the same clinker.

The powdered clinker recovered from the set paste by the use of alcohol was mixed with an appropriate amount of powdered gypsum, and it set and hardened normally. The setting is thus considered to be a mechanical process independent of the chemical process of hardening, but the two may overlap.

A Danish Alkali-Resistant Cement.

The following is abstracted from a report by Dr. Erik V. Meyer, issued by the Committee on Alkali Reactions in Concrete of the Danish National Institute of Building Research (20 Borgergade, Copenhagen K, Denmark).

As a result of experiments carried out in the U.S.A. and elsewhere it seems to be established that damage to concrete due to the reaction between some aggregates and the alkali content of cement can usually be prevented by using a cement with a sufficiently low alkali content. It was for some years considered that the total of $Na_2O + 0{\cdot}65.K_2O$ should not exceed 0·6 per cent.; this limit was considered to be too high and has been changed to 0·4 per cent. However, in addition to the quantity of alkali in the cement, alkali may also be introduced into concrete from other sources. For example, the mixing water may contain alkali and the aggregates may also contain minerals producing alkalis which may give rise to reactions although the cement may have such a low alkali content that such reaction would not take place normally.

In the year 1953 the Danish cement makers Aalborg Portland-Cement-Fabrik investigated the problem of making a cement which would prevent alkali-aggregate reactions even when alkali in addition to that contained in the cement is introduced into the concrete and when the aggregate contains alkali-reactive minerals.

Tests made after one year on a cement produced as a result of these investigations gave the following results.

Mortar made with cement containing 1 per cent. equivalent alkali, sand containing alkali-active minerals, and fresh water: Expansion 0·17 per cent.

Mortar made with cement containing 1 per cent. equivalent alkali, sand without alkali-active minerals, and fresh water: Expansion 0·02 per cent.

Mortar made with cement containing 0·4 per cent. equivalent alkali, sand with alkali-active minerals, and fresh water: Expansion 0·01 per cent.

Mortar made with cement containing 0·4 per cent. equivalent alkali, sand with alkali-active minerals, and sea-water: Expansion 0·17 per cent.

Mortar made with the new alkali-resistant cement, sand containing alkali-active minerals, and sea-water: Expansion 0·015 per cent.

The Sampling of Dust

Measurements of concentrations of dust and fume have been undertaken by the British Iron & Steel Research Association during recent years, and a report[1] has been issued describing some of the apparatus used and the procedure normally adopted for making these measurements. Extensive measurements have recently been made of the fumes emitted from two open-hearth furnaces; an account of this work was presented at the 47th Steelmaking Conference.[2] As a result of these tests it has been possible to design a sampling apparatus for the rapid measurement of red iron-oxide fume emitted with hot waste-gases from various steel-making processes. The apparatus can also be used to measure fine or coarse dust emitted from crushing, grinding, sieving, or other processes, and from sintering plants.

The arrangement of the apparatus, or sampling train, is shown schematically in *Fig.* 1. A stainless-steel probe, carrying a sharp-edged nozzle, faces directly into the stream of dusty gas and a sample is withdrawn isokinetically, that is it flows into the nozzle in the same direction and at the same velocity as the local undisturbed stream of gas. This ensures that the dust content of the sample

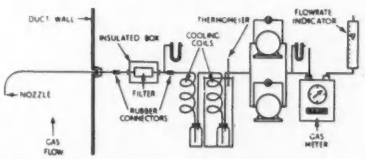


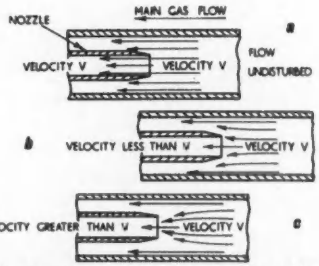
Fig. 1.—Sampling Train for Measurements of Open-hearth Waste Gases.

accurately represents that of the main gas-stream at that point. The sample of gas is then drawn through the weighed filter and is cooled below air temperature in the two coils to ensure that corrosive liquids are not condensed in the remainder of the sampling train. Two gastight vane-pumps, arranged in parallel, then expel the filtered and cooled gas sample through an integrating gas meter and a gas flow-rate indicator. The mass of dust and fume in the sample of gas is determined by reweighing the filter, and the concentration is obtained by dividing this mass by the volume of the sample of the gas.

In order to calculate the correct isokinetic sampling rate it is necessary to measure the velocity and temperature of the gases in the stack. This is done by placing a pitot tube and a sheathed thermocouple near the sampling nozzle, but not obstructing it. Simple tables can be used to obtain the required sampling rate from the pitot-tube reading. The full experimental procedure together

[1]R. A. Granville and P. Ball. B.I.S.R.A. Report P/3/56, " Sampling dust and fume-laden gases in ducts or chimneys."

[2]" Open-hearth furnace fumes: their formation and resulting problems." " Iron and Coal Trades Review," Nov. 30, 1956, p. 1315.



(a) Isokinetic sampling: true concentration obtained, particle size representative. (b) Sampling rate less than isokinetic; higher than true concentration obtained, excessive number of coarse particles in sample. (c) Sampling rate greater than isokinetic: lower than true concentration obtained, deficiency of coarse particles in sample.

Fig. 2.—Effect of Incorrect Sampling Velocity on Composition of Sample.

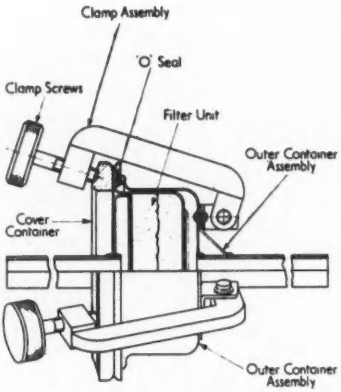


Fig. 3.—Prototype Filter.

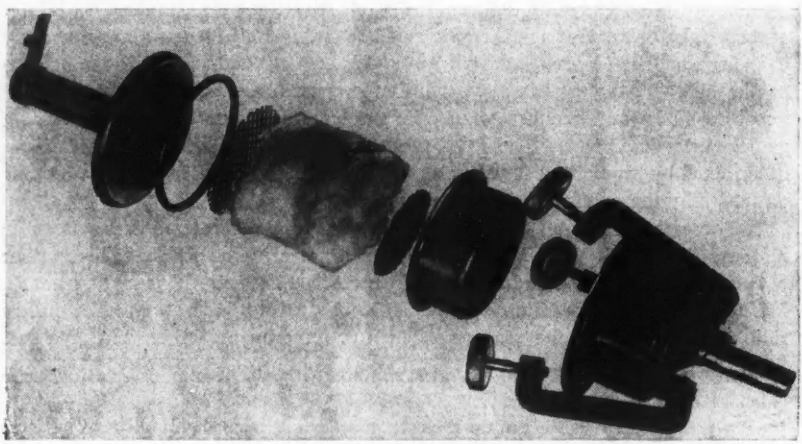


Fig. 4.—Details of the Filter.

with the details and examples of gas-velocity and sampling-rate calculations are given in the report.[1]

The arrangement of the sampling train shown in *Fig.* 1 with two vane-pumps connected in parallel has proved very convenient in use. Two small pumps are preferable to one larger one since they allow a wider range of sampling rates and easier control, as well as being easier to transport. Placing the meter after the pumps ensures that the sample is metered at substantially constant temperature and pressure. This simplifies the calculation of the concentrations of dust and fumes in terms of standard volumes of gas and makes it possible to use the simple form of sampling flow-rate control described. The inclusion in the sampling train of an integrating gas meter avoids determining the volume of the sample of gas by integrating a flow-rate time-diagram, which is a tedious and sometimes inaccurate procedure.

Rates of emission of gas and fume from steelmaking processes can vary rapidly with time. To be of use the sampling train must collect a weighable sample of dust and fume in a short period—often less than five minutes—and be ready to take another within a minute. To meet these requirements the original hand-built apparatus has been redesigned in collaboration with the Longworth Scientific Instrument Co., Ltd. A robust filter-assembly is being constructed which incorporates a throw-away filter of graded glass fibres, held in a re-usable stainless steel canister, the whole of which can be weighed on a chemical balance. This filter assembly and the preformed glass-fibre filters will be commercially available. They will filter iron-oxide fume from corrosive gases at 300 deg. C. at a rate of 3 cu. ft. per minute. Plans are now being made for the manufacture of the complete sampling train. The components are grouped in such a way as to provide a self-contained and compact apparatus. This advantage has been gained without sacrificing the great degree of flexibility in arrangement that is required when access to a duct or chimney may vary from the relative comfort of a staircase and flat floor to a hand ladder and roped scaffold plank.

Production of Cement in Mexico.

The production of cement in Mexico in the year 1957 was 2,500,000 tons, compared with 2,200,000 tons in the previous year. The new works at Ensenada, Baja California, of Cementos California S.A., has now started production. The cement industry in Mexico is now sufficient to meet all the requirements of the country.

Production of Cement in Italy.

In the year 1957 the production of cement in Italy was 11,900,000 tons; this is an increase of 600,000 tons compared with the previous year.

Proposed Cement Works in Syria.

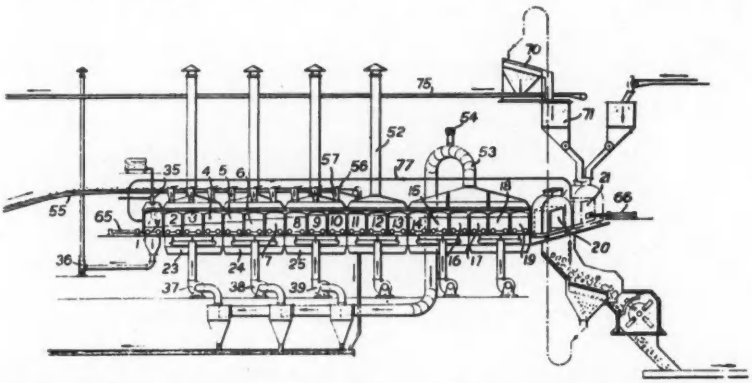
Societe de Ciment de Hama proposes to build a cement works at Hama. This is in addition to a cement works at Homs, for which a contract has already been let.

Patent Applications Relating to Cement.

Clinker-cooling Grates

A granulated mixture of raw cement material and solid fuel is formed into beds on grates in separate containers in which the burning cycles are staggered and air flows upwards through each bed. The containers are continuously or intermittently fed with additional mixtures of raw material and fuel as the burning progresses so that the depth of the bed increases as the burning progresses from the bottom upwards and the combustion zone, during the greater part of the burning, is always covered by a thin layer of fresh raw material and fuel. The burned beds of clinker are successively discharged so that cement is produced continuously.

Ignition of the containers in position (1) is aided by down-draught. Addition of the charge is related to the burning, so that by the time the container is full



the burning is nearly complete. A layer of pre-burned clinker is interposed between the bed of the grate and the lowest charge, and the proportion of fuel in the charge decreases from the bottom to the top of each container. Small sized pre-burned clinker may be included in the charge. An empty container is charged in position (21) and pushed along a track (77) by hydraulic means (66) to position (1) where the charge is ignited by burner (35), combustion air being drawn down by a blower (36). Hydraulic mechanism (65) pushes the container into each of the positions (2 to 19), each position being occupied by containers in progressive stages of burning or cooling. Subsequent charges are added from a conveyer (55), scrapers (56) and chutes (57). Burning is completed in position (13) though no more material is added after position (10). Cold air is supplied to positions (11) to (13) but the main cooling takes place between positions (14) to (19), cold air being passed through and heated. This heated air passes through pipe (53) into air-chambers (23, 24, 25) and through the charges in the containers in positions (2) to (10), by means of increasingly powerful blowers (37, 38, 39). A cold air mixing valve (54) in the pipe (53) regulates the temperature of the

preheated air. The containers are discharged in position (20) and the contents sieved, the coarse material being crushed. Fine material passes to sieve (70), the coarser fraction forming the grate covering clinker, the finer fraction being taken by a conveyer (75) to be mixed into fresh raw material. Some or all of the heated air passing through the pipe (53) may be used for drying cement slurry or generating steam, and the hot gases passing to atmosphere through a pipe (52) may also be employed similarly, and in this latter event the last layer charged to the containers is fuel only.—No. 728,836. Amalgamated Limestone Corporation, Ltd. June 10, 1953.

Cementitious Compositions

Binding agents are obtained by mixing at least 65 parts of anhydrite with at most 35 parts of another component selected from silicates and aluminates of Group IIA metals such as basic blastfurnace slag or natural and/or artificial pozzolana; 5 to 60 parts of pulverised-fuel ash may also be present. The anhydrite may be natural or synthetic or a mixture of both types. Other additions to the mixture are Portland cement; an alkaline earth metal hydroxide, for example, lime; a hardening or setting agent, for example hydrosulphate or sulphate of iron, potassium or zinc; and a water repellent, for example, a silicone, an alkali metal or alkaline earth metal silicate, fluosilicate, phosphate, aluminate, or stearate.—No. 778,968. Bureau d'Etudes et Laboratoires Annexes a l'Institut Meurice-Chimie Soc. and G. P. J. Maes. February 10, 1955.

Flotation of Slurry

Unground sedimentary low-grade raw material is separated into fine and coarse fractions, water is added to the fine fraction which is subjected to flotation to give a concentrate and reject, the concentrate is separated into a fine aqueous fraction and a coarse fraction of low water content, this coarse fraction is mixed with the initial coarse fraction, and the mixture with or without the addition of correcting materials or water is ground to form a cement slurry. Before the first separation the raw material is washed to separate adherent particles from one another. Very coarse particles may be removed before the first separation and rejected. Very fine particles of the fine fraction of the first separation are removed before flotation. The fine aqueous fraction of the second separation may be used as diluting water.—No. 768,301. F. L. Smidth & Co. Aktieselskab. February 24, 1955.

Water Content of Slurry

The water content of cement slurries is reduced by incorporating a salt or an amine salt (defined as being a compound of the acid with an amine) of (*a*) an at least tri-basic organic acid obtained by polymerising at least once an acid containing the -CH = CH- group or by co-polymerising such an acid with a polymerisable monomer, or of (*b*) an at least tri-basic poly-nuclear aromatic or heterocyclic acid. A proportion of 0·001 to 0·05 per cent. is preferred, and specified

acids are polyvinyl sulphonic acid, polyacrylic acid, naphthalene tri- or tetra-sulphonic acid, carbazole tetra-sulphonic acid, naphthol tri-sulphonic acid, a condensation product of 1-sulphomethyl-2-naphthol-C-sulphonic acid with cresol-formaldehyde resin, or a co-polymer prepared from maleic acid, acrylic acid, crotonic acid, or vinyl sulphonic acid. Other compounds may be added, for example a salt of diglycollic or 4, 4′, di-hydroxy-diphenyl methane-3, 3′-dicarboxylic acid. Further additions may also be made, for example salts of inorganic polyacids, surface active organic compounds, and alkali carbonate or hydroxide.—No. 777,940. Farbwerke Hoechst Akt.-Ges. Vorm. Mesiter Lucius & Bruning. November 18, 1953.

High-alumina Cement

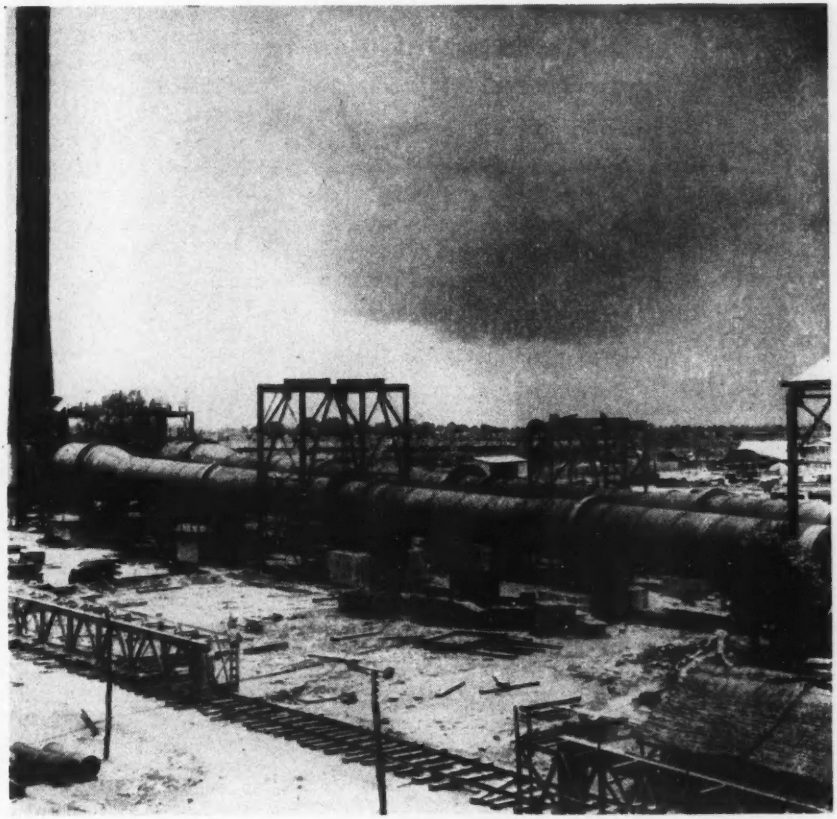
High-alumina cement is made by heating a mixture of ground limestone and bauxite and a compound of the metals of Group IV or VI of the periodic table to a temperature below fusion. Specified compounds are oxides, hydroxides, carbonates, nitrates, or phosphates of zirconium, lead, tin, chromium, molybdenum, and tungsten, the preferred compounds being lead oxide or chromium oxide in the preferred proportion of 2 to 8 per cent. of the mixture. A temperature of 1200 deg. to 1400 deg. C. is specified.—No. 777,564. Seco Soc. Anon. Brig. Soc. pour l'Etude et la Construction d'Enterprises Industrielles. August 20, 1953.

Composition of Cement

Portland cement and lime are incorporated into an aqueous binder phase comprising 0·7 to 1·5 per cent. by weight of methyl cellulose and from 7 to 15 per cent. of a polyvinyl ester (specifically polyvinyl acetate) until a uniform suspension is obtained; other fillers may be added, for example, pigments, sand, and chalk. The suspension may be coated in layers on plaster of Paris, lime mortar, cement plaster, oil or wax paint coated surfaces, wood, or fibre boards. A preferred mixture, the proportions being by volume, is 1 : 3 parts 30 per cent. aqueous suspension of polyvinyl acetate stabilised with polyvinyl alcohol, 2 : 3 parts 1·5 per cent. aqueous solution of methyl cellulose, 2 parts of a mixture comprising 4 parts Portland cement, 1 part lime, 1 part sand, and 1 part pulverised whiting. —No. 743,952. J. Spillman-Zuppinger and G. Pietro Boni. October 26, 1954.

Burning Cement

Uniform-sized pellets of cement powder and coal are coated with a uniformly thick fuel-free shell, the carbon content of the core being less than that corresponding to Havenschild's equation, and are burned in shaft kilns operating on the counter-flow principle. The shell may be formed from the cement powder, burnt clinker dust, or residue dust. The coal may be ground to less than 1 mm. diameter. Regulation of the fuel-to-air ratio may be obtained by varying the thickness of the shell and the diameter of the pellet.—No. 768,294. Portland-Zementwerke Heidelberg Akt.-Ges. December 31, 1954.



UTTAR PRADESH CEMENT WORKS

Designed to produce 700 tons of Portland Cement a day, the Government Cement Factory at Churk was equipped with machinery by Vickers-Armstrongs. The kilns, mills, primary crusher and other major units were manufactured at Barrow and the project was completed in 1954.

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The Cement Industry in Great Britain.

THE following is abstracted from the address of the Chairman, Mr. J. A. E. Reiss, B.E.M., at the annual general meeting of the Associated Portland Cement Manufacturers, Ltd., held in London last month.

Last year the building trade began to feel the effects of the Government's policy of credit restrictions, and the change from a seller's to a buyer's market took place in the late spring. By the end of last year deliveries at home were about 5 per cent. less than in 1956, and it was the first year since the war that a reduction had taken place. In 1956 the cement industry undertook not to increase home prices during the year ending June 30, 1957, when an increase of just under 7s. a ton had to be made to meet additional costs, principally of fuel and power. A further undertaking was given to maintain the new prices for another year unless there was an increase in the cost of coal or other exceptional circumstance.

It was a difficult year in the export trade. Competition from eastern Europe was not as severe as in the previous year, but a great deal of new production was started in different parts of the world with the result that total world exports decreased. Despite these factors, and increasing Japanese competition aided by subsidised freights, the company exported over a million tons of cement, albeit at substantially lower prices.

It would be reasonable to assume that deliveries at home in 1958 would not be less than 90 per cent. of last year's deliveries. The impact of this smaller production might not be unduly severe, because the Company had been producing since the war at a rate considerably in excess of the design capacity of its works, with the result that some loss in efficiency was inevitable, particularly in fuel consumption, and a large amount of night and week-end work at high overtime rates was necessary.

The present trend of trade was therefore providing an opportunity of returning to more normal operating conditions, and since the middle of last year very satisfactory savings in fuel consumption had been achieved, whilst several old and uneconomical kilns which were operated during the period of peak demand had been closed down.

A great deal of attention was being paid to the production of cements for special purposes. During the year a new type of oil-well cement and a hydrophobic cement were introduced.

Negotiations were in progress to acquire the cement works of the Amalgamated Limestone Corporation, Ltd., at Plymouth, which comprised two shaft kilns with an annual capacity of 80,000 tons and ample limestone deposits; the intention was to install a rotary kiln to serve a greater part of Devon and Cornwall. This development was a result of the present high cost of delivering cement by coasting vessels, due mainly to the very high port and handling costs compared with pre-war days, which made coastwise deliveries in bags increasingly uneconomical.

Another difficult year with decreasing profits was expected in the export market. On the other hand, the Company was supplying some large contracts

abroad, and expected only a small decrease in volume. Since the war the Company's interests oversea had been greatly expanded; the works oversea achieved a record production of over 2,000,000 tons last year, which was more than three times as much as in 1948. These works make a growing contribution to the profits and, while there were indications of an easing in the demand for cement in some countries, prospects generally were regarded as satisfactory.

In Australia, the Commonwealth Portland Cement Co., Ltd., in New South Wales, had a record year. A third kiln had been brought into operation and the works was producing to capacity and finding a market for its output. These conditions appeared likely to continue.

The annual capacity of the British Columbia Cement Co., Ltd., was now 550,000 tons, the latest kiln being installed last year. During the year this company was merged with other important trading interests in the Province and a new holding company, Ocean Cement & Supplies, Ltd., was formed. The company had a good year and, notwithstanding the more difficult trading conditions generally in Canada, made a satisfactory start this year.

The new works of the East African Portland Cement Co., Ltd., in Kenya, in which they were shareholders in conjunction with other interests, had recently come into production. The works had a capacity of 120,000 tons of cement a year and would replace a plant at which imported clinker had been ground.

The Malayan interests continued to expand, and a new kiln, which would double the annual capacity to 220,000 tons, was expected to be in operation within a few months.

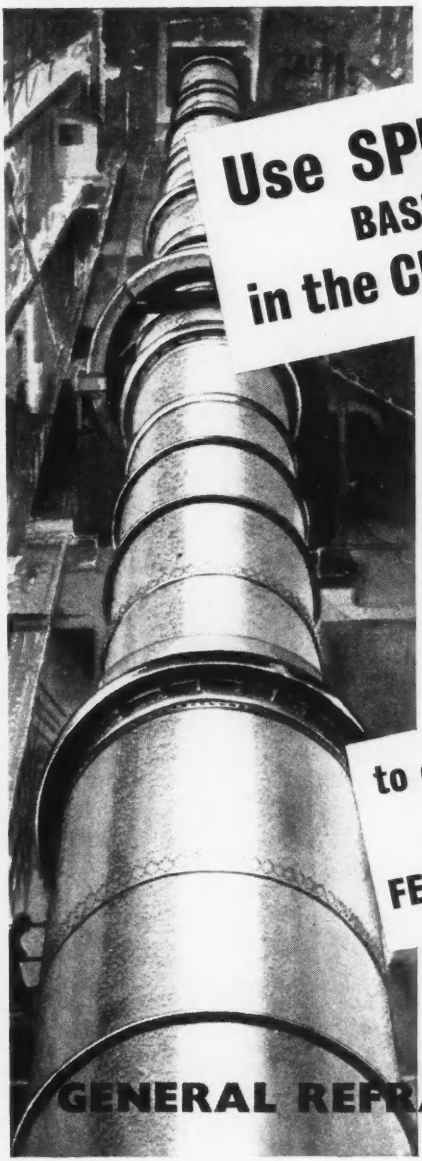
In Mexico the sales and profits of the Mixcoac and Tolteca works created records. An additional kiln was being installed at Tolteca and would be in operation shortly; the total capacity of the two works would then amount to 780,000 tons a year. In addition a new works with a capacity of 300,000 tons a year was to be built about forty miles from Mexico City.

The two kilns of the Golden Bay Cement Co., Ltd., in New Zealand, had an annual capacity of 160,000 tons, and a new kiln with a capacity of 200,000 tons was being installed.

White's South African Portland Cement Co., Ltd., owned two works, one in the Orange Free State and one in the Transvaal, which together produced over 650,000 tons a year, and the capacity was to be further increased.

The new works of the Salisbury Portland Cement Co., Ltd., in Southern Rhodesia started production last August. This works had a capacity of 120,000 tons of cement and was favourably placed to secure the business of the growing Salisbury market.

Agreement had been reached with the Western Region Production Development Board, a Government sponsored body in Western Nigeria, and the United Africa Co., Ltd., to build a cement plant, with a capacity of 200,000 tons, forty miles from Lagos, and work on the site was in progress. This works would be the largest industrial undertaking in Nigeria and their Company would have a majority interest in the operating company.



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